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ORIGINAL RESEARCH

Assessment of Dry Eye Disease Symptoms in Health Science University Students: A Combined Approach Using CVS-Q and Schirmer Tear Test to Evaluate the Influence of Digital Devices

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Background: The swift development of our digital lives has led to a significant reliance on devices for everyday tasks, including education. The adverse effects of these devices on health are the subject of numerous studies and investigations. In this study, we assessed the relationship between answers to the Computer Vision Syndrome Questionnaire (CVS-Q) and the Schirmer tear test for the detection of symptoms of Dry Eye Disease (DED). Qualitative and quantitative data were combined to examine the association between electronic device use and the appearance of such symptoms in health science students in Saudi Arabia.

Methods: A cross-sectional study was conducted at King Saud bin Abdulaziz University for Health Sciences in Jeddah among 111 students from October 2023 to May 2024. DED symptoms were investigated in two steps: first, using the CVS-Q; and second, with the Schirmer tear test under topical anesthesia (1.0% tetracaine hydrochloride eye drops).

Results: The CVS-Q findings showed that a majority of students (58.9% of males and 86.8% of females) used tablets for online courses. The average distance at which the students placed their devices from their eyes was between 25cm and 45cm (58.9% of males, 65.79% of females). Most students (90.4% of men, 92.1% of women) used devices for more than five hours a day. Women reported more DED symptoms than did men, especially burning, dryness, and headache (63.16%), while the men mostly experienced dryness (47.95%). The CVS-Q indicated that 41.10% of males and 57.89% of females had dry eyes, while the Schirmer test indicated that 30.14% of males experienced greater dryness. A negative correlation was found between CVS-Q scores, Schirmer test results, and the influence of digital device use among students, by gender.

Conclusion: This study found that assessing DED–like symptoms via the link between the CVS-Q score and the Schirmer test may indicate the influence of digital device use among healthcare students.

Keywords: digital devices, dry eye disease symptoms, health science university students, Schirmer test, gender difference

Introduction

The use of digital devices has become essential in education and for professional development. All healthcare student activities, from attending online lectures to conducting research, involve prolonged screen use.[1] According to the American Optometric Association,[2] the intensive use of digital devices has led to an increased prevalence of several ocular diseases, including DED[3] and digital eye strain.[4] Previous studies have suggested that excessive use of digital devices is a leading risk factor in the development of DED among university students.[4–7]

DED is a multifactorial disease of the ocular surface, characterized by loss of homeostasis of the tear film and accompanied by ocular symptoms, in which an etiological role is played by instability and hyperosmolarity of the tear film, inflammation and damage to the ocular surface and neurosensory abnormalities.[8]

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The symptoms of DED are considered to range from mild to severe and include burning or itchy eyes, headaches, eye pain, frequent blinking, and sensitivity to light.[9] Sufferance with these symptoms significantly hinders daily and social activities, as well as productivity, among the affected population.[10]

Various methods are used to determine the presence and severity of DED symptoms objectively. These include the Ocular Surface Disease Index Questionnaire, Schirmer tests, and the tear film break-up time.[11,12] The Computer Vision Syndrome Questionnaire (CVS-Q) has been shown to provide the same accuracy as these methods in the determination of DED symptoms.[13] The application of multiple methods provides consistency between measured data and reported symptoms.[14] This study employed a robust, combined approach that used the CVS-Q and Schirmer tear test to validate the assessment. The CVS-Q was used to identify DED symptoms as reported by each participant, after which the Schirmer tear test was used to validate that identification through clinical signs.

Hence, the primary objective of this study was to assess the relationship between CVS-Q and the Schirmer tear test to improve the detection of DED symptoms. Secondly, employment of this combined qualitative and quantitative approach enabled us to investigate the association between the use of electronic devices and the occurrence of symptoms among health science students at King Saud bin Abdulaziz University for Health Sciences (KSAU-HS) in Jeddah, Saudi Arabia.

Methods

Study Population

A total of 111 students stated that they were willing to take part in this cross-sectional study, which was conducted between October 2023 and May 2024. Informed written consent was obtained from all participants before the testing sessions. Any students who were under 18 years old or who had undergone a vision correction process or were wearing contact lenses were excluded. Figure 1 shows the participant flow diagram.

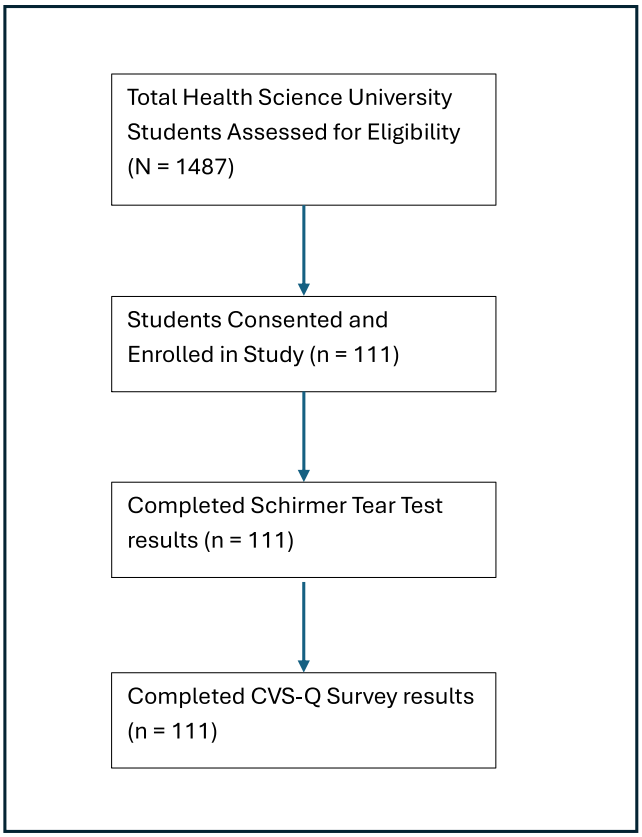

Figure 1 Participant Flow Diagram for the Cross-Sectional Study.

Data Collection

Tests to investigate DED symptoms were performed with each participant in two consecutive steps in the same session. The first step involved the application of the CVS-Q in an interview.[13] The questionnaire answers were collected using Microsoft Forms.

The second step involved application of the Schirmer tear test with topical anesthesia (1.0% tetracaine hydrochloride eye drops).[15] A 5 × 35 mm Schirmer strip produced by the Tear Touch Company was used for each test.

A previous study had demonstrated a high correlation between the maximum wetting saturation time of the two-minute Schirmer test with anesthesia and that of the five-minute test.[16] Therefore, this study was conducted over two minutes, during which the wetted length of the paper was directly measured and interpreted. A reading of ≤15mm wetted length indicated the presence of DED, with severity categorized as mild (≤15mm), moderate (≤10mm), or severe (≤5mm).[17] The Schirmer test was conducted by ophthalmology consultants, and the variability of tear production between the left and right eyes was taken into account.[18,19]

The Declaration of Helsinki guidelines were followed throughout the study. Before the study commenced, participants provided informed consent by checking the appropriate box on a consent form. The institutional review board at King Abdullah International Medical Research Centre approved the study (IRB NRJ21J/296/12).

Computer Vision Syndrome Questionnaire

The rationale for using the CVS-Q was to explore the factors associated with digital device use and DED symptoms.[11–13] The CVS-Q questions were categorized into three sections: students' demographic information, their use of electronic devices, and their DED symptoms. The demographic information section covered age, gender, academic level, and smoking habits. The electronic device information section covered the types of devices students frequently used for studying and entertainment, along with the time they spent on these devices. The DED symptoms section included 16 symptoms and the frequency and intensity with which respondents experienced them.

The symptoms included burning, blinking, dryness, itching, heaviness, pain, watering, altered sensation, and redness, as well as eye strain symptoms such as increased sensitivity to light, halos around objects, and fluctuating eyesight. The frequency and intensity of the symptoms were measured on a five-point scale: never, occasionally moderate, occasionally severe, always moderate, and always severe. The overall CVS-Q scores were calculated according to the formula specified by Mohan et al.[13] Scores between 0 and 5 points indicated no DED signs, whereas scores from 6 to 32 indicated notable DED symptoms.

Statistical Analysis

The statistical analyses were carried out using Python (version 3.12, 2023). The qualitative data were presented in numbers (N) and percentages (%). Chi-square or Fisher's exact tests were used to assess the associations between categorical variables. The correlation among genders (male and female), CVS-Q score, and the Schirmer test (left eye and right eye) was analyzed using Spearman's rank correlation coefficient (r).

Subjects with specific characteristics were studied further to examine the correlation between their CVS-Q scores and Schirmer test results. The characteristics were: the subjects' favorite device was a tablet, the average distance between the screen and their eyes was 25–45 cm, and they spent five hours or more each day on digital devices. A p-value of <0.05 was considered the threshold for statistical significance.

Results

Descriptive Analysis of CVS-Q

Of the 111 participants, 66% (n=73) were males, and 34% (n=38) were females. Their age distribution was: 25% (n=28) were between 18 and 20 years old, 73% (n=81) were between 21 and 25 years old, and 2% (n=2) were 26 years old and above (Table 1).

The distribution of participants in terms of their year of study was: 5.4% (n=6) were in their first year, 8.1% (n=9) in their second year, 14.4% (n=16) in their third year, 17.1% (n=19) in their fourth year, 13.5% (n=15) in their fifth year,

Table 1 The Demographic Information

Question	N		Percentage (%)		P-value
	Male	Female	Male	Female	
Gender					——
	73	38	65.77	34.23	
Age (Years)					0.423
18 - 20	20	8	18.02	7.21	
21 - 25	51	30	45.94	27.03	
26 and above	2	0	1.80	0	
Academic Year					<0.001
1st	6	0	5.41	0	
2nd	0	9	0	8.11	
3rd	16	0	14.41	0	
4th	8	11	7.21	9.91	
5th	15	0	13.51	0	
6th	28	16	25.23	14.41	
7th	0	2	0	1.80	
Attending Online Courses					0.172
Yes	53	27	47.75	24.32	
No	3	5	2.70	4.50	
Sometimes	17	6	15.32	5.41	
Smoking Status					0.672
Never smoked	48	28	43.24	25.23	
Occasional smoker	6	2	5.41	1.80	
Heavy smoker	6	1	5.41	0.90	
Former smoker	1	0	0.90	0	
Second-hand smoker	12	7	10.81	6.30	

39.6% (n=44) in their sixth year and 1.8% (n=2) in their internship program. Additionally, 72% (n=80) of the students attended online courses, while 20.72% (n=23) sometimes attended online courses, and 7.2% (n=8) did not (Table 1).

The distribution of smoking behaviors among the participants was as follows: 68.5% (n=76) had never been smokers, 0.9% (n=1) were former smokers, 7.21% (n=8) were occasional smokers, 6.3% (n=7) were heavy smokers, and 17.2% (n=19) were second-hand smokers (Table 1).

Among the demographic variables, the distribution of students by academic year differed significantly between males and females (χ^2-test, $p < 0.001$). No significant gender differences were found in age groups, online course attendance, or smoking status ($p > 0.05$).

The most frequently used device for online courses was the tablet (males, 58.9%, n=43; females, 86.8%, n=33). The type least used was a desktop personal computer (males, 12.3%, n=9; no females) (Table 2).

Table 2 Electronic Device Information Categorized by Gender

Question	Male		Female		P-value
	N	Percentage %	N	Percentage %	
Type of Electronic Device Used for Online Courses					0.0157*
Laptop	14	19.2	4	10.5	
Desktop	9	12.33	0	0	
Smartphone	7	9.5	1	2.6	
Tablets	43	58.9	33	86.8	
Average Electronic Device's Screen Distance During Studying					0.1852
25–45 cm	43	58.9	25	65.79	
46–50 cm	15	20.5	11	28.9	
51–64 cm	14	19.1	2	5.2	
Greater than 65 cm	1	1.37	0	0	
Total Hours Using an Electronic Device:					0.4314
Daily Screen Time					
3 Hours	1	1.37	0	0	
4 Hours	5	6.85	1	2.63	
5 Hours	1	1.37	2	5.26	
More than 5 Hours	66	90.41	35	92.11	
TV Watching					0.1340
Less than 1 Hour	50	68.49	31	81.58	
1–2 Hours	17	23.29	3	7.89	
More than 2 Hours	6	8.22	4	10.53	
Mobile Gaming					0.1289
Less than 1 Hour	51	69.86	33	86.84	
1–2 Hours	7	9.59	1	2.63	
More than 2 Hours	15	20.55	4	10.53	

Note: *Indicates statistical significance difference at the $p < 0.05$ level.

In terms of the distance between the devices and the eyes, it was found that the students most commonly placed their devices between 25cm and 45cm away (males, 58.9%, n=43; females, 65.79%, n=25) and few students placed it >65cm away (males, 9.59%, n=7; females, 2.63%, n=1) (Table 2).

Most students spent more than five hours on their devices each day (males, 90.4%, n = 66; females, 92.1%, n = 35). The least was three hours; only one male student, 1.37%, fell into this category.

Most of the participants, male and female, spent less than an hour a day watching television (males, 68.5%, n=50; females, 81.6%, n=31), and the fewest watched for more than two hours a day (males, 8.22%, n=6; females, 10.53%, n=4).

Regarding video gaming, most students spent less than an hour playing daily (males, 69.86%, n=51; females, 86.84%, n=33). The smallest number spent between one and two hours a day playing (males, 9.59%, n=7; females, 2.63%, n=1) (Table 2).

There was a statistically significant association between gender and the type of electronic device used for online courses, as indicated by a chi-square test (χ^2, p=0.0157). No significant differences by gender were detected in screen distance, daily screen time, or television viewing or gaming duration ($p > 0.05$).

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Comparison of the Results According to Gender

Comparison of Experiences of DED Symptoms According to CVS-Q Scores

The occurrence of DED symptoms was compared by frequency (always or occasionally) and intensity (moderate or severe). It was found that female students reported more DED symptoms than did male students. As shown in Table 3, the majority of female students reported symptoms of burning, dryness, and headache (63.16%), whereas the most frequently cited symptom among male students was dryness (47.95%). The differences in the proportions of female students compared with males who reported burning (63.16% vs 39.73%), blurring (50% vs 28.77%), and headache (63.16% vs 30.14%) were all statistically significant (p=0.027, 0.037, and 0.001, respectively). No other symptoms differed significantly between genders ($p > 0.05$). Fisher's exact test was employed to calculate the p-values for each symptom.

Comparison of Questionnaire Scores with Schirmer's Tear Test Results

Comparison of tear production using the Schirmer test revealed that 30.14% of male students had more dryness in their right eyes than in their left, while 44.73% of female students had. Meanwhile, 38.36% of male students had more dryness in their left eyes than in their right, compared with 34.21% of female students. These data are shown in Table 4. The CVS-Q scores indicated that 41.10% (n=30) of the male participants and 57.89% (n=22) of the female participants had dry eye, as shown in Table 4. Neither the Schirmer tear test results according to right or left eye nor the CVS-Q results were significantly different in terms of gender ($p >0.05$).

Correlation Between CVS-Q Score and Schirmer Tear Test for Electronic Device Use Habits Based on Gender

The correlation matrix for CVS-Q scores versus Schirmer tests, by gender (23 males and 21 females), showed negative correlations among males and females. The CVS-Q scores and Schirmer tear tests showed no statistical significance for

Table 3 The DED Symptoms by Gender

Symptom	Male N (%)	Female N (%)	P-value
Burning	29 (39.73%)	24 (63.16%)	0.0272*
Itching	30 (41.10%)	19 (50.00%)	0.4232
Foreign Body	33 (45.21%)	20 (52.63%)	0.5489
Watering	30 (41.10%)	18 (47.37%)	0.5506
Blinking	21 (28.77%)	12 (31.58%)	0.8279
Redness	20 (27.40%)	17 (44.74%)	0.0895
Pain	9 (12.33%)	8 (21.05%)	0.2703
Heaviness	7 (9.59%)	5 (13.16%)	0.5407
Dryness	35 (47.95%)	24 (63.16%)	0.1616
Blurring	21 (28.77%)	19 (50.00%)	0.0371*
Double Vision	5 (6.85%)	1 (2.63%)	0.6621
Focusing Near	9 (12.33%)	9 (23.68%)	0.1739
Halos	24 (32.88%)	13 (34.21%)	1
Sensitivity	26 (35.62%)	21 (55.26%)	0.679
Headache	22 (30.14%)	24 (63.16%)	0.0011*
Worsening Eyesight	26 (35.62%)	19 (50.00%)	0.1587

Note: *Indicates statistical significance difference at the $p < 0.05$ level.

Table 4 DED Examination Using Schirmer's Test and CVS-Q Score

DED Examination Methods	EYE	Gender		P-value
		Male (N, %)	Female (N, %)	
Schirmer Tear Test	Right	22 (30.14%)	17 (44.73%)	0.146
	Left	28 (38.36%)	13 (34.21%)	0.836
CVS-Q Score	0–5 (NDE)	43 (58.90%)	16 (42.11%)	0.111
	6–32 (DE)	30 (41.10%)	22 (57.89%)	0.111

Note: CVS-Q score: Not Dry eye disease (0–5), and Dry eye disease (6–32).

Table 5 The Correlation Matrix for the CVS-Q Score versus the Schirmer Test Based on Gender

	Male (n=23)		Female (n=21)	
	CVS-Q SCORE (r)	p	CVS-Q SCORE (r)	p
Schirmer's Test Right Eye	−0.28	0.191	−0.19	0.414
Schirmer's Test Left Eye	−0.25	0.255	−0.18	0.445

the right or left eyes according to gender (males, r=−0.28, p=0.191, and r=−0.25, p=0.255, respectively; females, r=−0.19, p=0.414, and r=−0.18, p=0.445, respectively) as shown in Table 5.

Discussion

The authors investigated the relationship between electronic device use and DED symptoms among health science university students, focusing on the correlation between CVS-Q scores and Schirmer test results.

The demographic data for the participants showed that the majority often attended online courses.[20] Male and female students preferred to use tablets as their digital devices for these courses.[21,22] Surprisingly, no female students considered personal computers their favorite type of device.[23,24] Most of the students maintained a short distance (25–45cm) between their devices and their eyes; this finding aligns with previous work.[5,7,25]

The study found that most students spent five or more hours each day on their devices.[26] The majority reported spending less than one hour a day watching television. This finding differs from that of another recent study among medical students in Saudi Arabia, which found that 91% of them watched medical television dramas and engaged with them.[27]

This work also found that students spent less than one hour per day playing video games. This finding is consistent with that of a previous study, which examined the prevalence of gaming addiction among medical students and reported a low rate of such addiction.[28]

Regarding the experiences of DED symptoms by each gender, it was found that burning,[29] dryness, and headache were experienced more by female students than male,[30] but in contrast, the male students reported the highest level of dryness.[31]

This was an exploratory study to assess the correlation between the CVS-Q score and the Schirmer tear test in the assessment of DED symptoms. The Schirmer tear test was used to assess tear production as a diagnostic tool for DED in students. A study by Li et al showed that patients with DED produced Schirmer test results of <10mm wetted length of the test strips.[15] Additionally, in this study, the CVS-Q score was used to investigate DED symptoms in students. A survey by Estares et al indicated that patients with DED had CVS-Q scores greater than 6.[32] This study showed a negative correlation between the CVS-Q scores and Schirmer test results in both females and males. This result aligns with a study by Sánchez-Valerio et al, which showed that the Schirmer test and CVS-Q scores were associated with DED.[33]

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Frequent use of electronic devices increases the rate of occurrence of DED symptoms in patients; university students must undergo routine testing to ensure that their ocular surfaces remain healthy and to prevent the onset of DED symptoms.

This study suggests that the CVS-Q is a reliable tool for assessing DED, particularly for initial screening to prevent underdiagnosis and aid in the development of treatment plans. Physicians could find a helpful tool to combat common underdiagnosed conditions, such as DED. The widespread adoption of the CVS-Q could improve the outcomes of public health initiatives related to DED by streamlining clinical workflows, reducing diagnostic delays, and ensuring that more patients receive timely, appropriate treatment.

Study Limitations and Future Work

The authors of this exploratory study aimed to evaluate the relationship between CVS-Q scores and the Schirmer tear test for the effective detection of DED symptoms. The limitations of the study include a small sample size, typical of exploratory studies, which restricted its scope. The findings from this small study cannot be generalized to the entire population, nor can definitive conclusions be made. Another limitation was reliance on the Schirmer tear test with anesthesia, which has low sensitivity for detecting mild-to-moderate DED. Although it is an objective measure of tear production, its poor sensitivity is likely to lead to underestimations of DED prevalence. Future research should include more comprehensive tests, such as blood markers, alongside comprehensive clinical examinations, including ocular tests, to confirm a diagnosis of DED. This approach would enable more precise analysis of biological differences and enhance biomarker-based detection.

Conclusion

The relationship between digital device usage and the incidence of DED symptoms among health science students at KSAU-HS in Jeddah, Saudi Arabia. The study found gender differences in dry eye symptom experiences, with female students reporting greater severity than male students. The negative correlation between the Schirmer tear test and the CVS-Q score supports the reliability of these diagnostic methods in identifying DED. The increasing use of digital devices in education necessitates greater emphasis on DED preventive measures, such as screen time breaks, and on raising awareness of the relationship between device use and ocular health to improve students' quality of life.

This study's assessment of DED symptoms in male and female health science students at KSAU-HS in Jeddah, Saudi Arabia, has used the correlation between CVS-Q scores and Schirmer test results to indicate possible associations among factors related to digital device use. To mitigate the negative impacts of such devices on students' quality of life, their increasing use in the classroom necessitates a greater focus on DED preventive strategies, including screen time breaks and educating students about the consequences of device use on ocular health.

Data Sharing Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Ethics and Consent-to-Participate Declarations

The study was approved by the Institutional Review Board of King Abdullah International Medical Research Centre (IRB NRJ21J/296/12). No animals were used in this research. All human research procedures were followed in accordance with the ethical standards of institutional and/or research committees and with the 2013 Declaration of Helsinki, as revised from the 1975 Declaration.

Author Contributions

All authors made a significant contribution to the work reported and approved the final manuscript version. AYA served as the principal investigator, responsible for conceiving and designing the study. AYA and RA were the supervisors of the study, including the data collection and processing. AYA, RA, AA, MFG, and ASA were all involved in subject recruitment and data collection. AA specifically contributed to data analysis and the critical review of intellectual, research, and statistical content. AYA and RA wrote the final manuscript version. All authors participated in the critical

review of the article, gave final approval of the version to be published, agreed on the journal to which the article was submitted, and agree to be accountable for all aspects of the work.

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The authors declare that they have no competing interests in this work.

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